"$100 Is Not Much To You": Open Science and Neglected Accessibilities for Scientific Research in Africa

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Abstract (233 words): The Open Science movement promises nothing less than a revolution in the availability of scientific knowledge around the globe. By removing barriers to online data and encouraging publication in Open Access formats and Open Data archives, Open Science seeks to expand the role, reach and value of research. The promises of Open Science imply a set of expectations about what different publics hope to gain from research, how accountability and participation can be enhanced, and what makes science public in the first place. This paper presents empirical material from fieldwork undertaken in (bio)chemistry laboratories in Kenya and South Africa to examine the extent to which these ideals realised in a sub-Saharan context. To analyse the challenges African researchers face in making use of freely available data, we draw from Amartya Sen's Capabilities Approach, His theorisations of 'conversion factors' helps to understand how seemingly minor economic and social contingencies can hamper the production and (re-)use of online data. In contrast to initiatives that seek to make more data available, we suggest the need to facilitate a more egalitarian engagement with online data resources.

Keywords (3-5): Open Science, African science, data sharing, research environments, public engagement

Introduction

The Open Science (OS) movement seeks to transform how we think about the collection, dissemination and value of data, the collaborative potential in science, and the public character of research. Through a number of linked initiatives, from promoting Open Access (OA) journals and Open Data (OD) repositories to advocating innovations in research practice such as crowdsourcing and 'open notebook science', the OS movement has sought to increase the availability of scientific information to a wider range of users (Molloy 2011). Increased access to data, it is believed, will work to reduce duplication and waste in public spending but also creating more opportunities for the governmental application and commercial exploitation of findings (Science International 2015). This opening-up science, rendering its practice and outcomes transparent, ideally can prompt a reflexive assessment of what kinds of research are most valuable and, critically, a re-conceptualization of the relationship of science to its publics (c.f. Stilgoe, Lock and Wilson 2014; Leach, Scoones and Wynne 2005).

The egalitarian aspirations of the OS movement underpin many efforts to build research capacity in low/middle-income countries (LMICs), where access to research outputs, including both papers and data, remains limited (c.f. Duque et al. 2005; Shrum 2005). The assumption that "giving free Internet access to scientific results and data offers opportunities to foster collaboration between scientists in the developing and developing world" has precipitated new approaches to data dissemination, including the removal of OA author fees, the construction of databases and repositories, as well as the establishment of data moratoria for publishing (Global Young Academy 2012; cf. UNESCO 2010; Suber 2012; OECD 2015)). Gaining access to the growing amount of data online, will allow LMIC scientists to build their research networks and enhance their productivity and competiveness, ultimately shrinking global disparities in research activities and outputs and enriching the democratic potential of science.

As the OS movement progresses, however, the challenges of ensuring equitable and effective openness across a diversity of users have also become apparent. Rendering science 'open' involves contextualizing, cleaning and curating data so it can be searched and utilised—a process which is labour intensive, costly and dependent upon infrastructural capacities that tend to be obscured by policies seeking to maximize the availability of information online (Leonelli 2010, 2013; Borgman 2015). Furthermore, it is recognized that socio-cultural values and political biases are embedded into the very aesthetics of platform design, from the ways in which data is laid out, searched and linked to how communities of users communicate (eg. Marres & Rogers 2005; Polikanov & Abramova 2003; Di Maggio & Hargittai 2001). Even more broadly, the variety of information and communication technology (ICT) systems, national infrastructures and research environments necessary to generate, process, disseminate and re-use data are just starting to be examined (e.g. Duque et al. 2009; Ynalvez and Shrum 2011).

These issues clearly highlight the need for a careful and critical analysis of precisely how OS initiatives aimed at addressing the needs of LMICs are structured and rolled out. Drawing on fieldwork with scientists in Kenya and South Africa, this paper examines the extent to which the ideals of data access and re-use are realised in a sub-Saharan context. It does so by reflecting upon the commonplace assumptions made within Western-based OS discussions about the needs and capabilities of those meant to realize the benefits of data, namely the scientists themselves. In particular we highlight the importance of seemingly minor everyday considerations in research laboratories that hamper the production and use of data and publications, in ways that are out of line with the assumptions made within OS literature about the physical, social and regulatory research environments in which scientists operate. These disparities are difficult to articulate within contemporary science policy, let alone to address.

In recognition of these challenges, we conclude the paper with suggestions for how to approach the building of research capacity in LMICs, which in turn may enable alternative forms of public engagement with science. Ultimately, we hope that this analytical re-description of the various constrains on African science can provide some further critical resources in rethinking how the publics of public health in Africa might be constituted.

It's the Little Things that Matter

Between 2014 and 2015 one of the authors (LB) conducted embedded, qualitative, fieldwork over a period of five months in four (bio)chemistry laboratories located in national universities in Kenya (KY) and South Africa (SA). [1] To best illuminate the everyday practices of data use in the region and their potential relevance for OA policy, we selected sites in countries with a robust history of scientific research and that represent major contributors to Africa's scientific output. We also chose to focus on university laboratories, which, while having engaged in foreign collaborations and received foreign grants, were not part of large research networks. This selection allowed us to get a good understanding of how the ideals of open science are taken up within the context of a specifically African public institution, illuminating perspectives and practices that might otherwise be obscured by the cultures of a transnational research.

Through interviews, informal discussions and observational work within the laboratories, we sought to come to grips with the routine practices of research and the broader social and material contexts of engagement with online data. Prompted by researchers' own accounts of their work, this empirical focus extended beyond the quality of ICT infrastructure; for while clearly central to researchers' capacity to search and share findings with a scientific community

beyond their lab, connectivity and hardware were only one in a series of factors affecting the integration of online data into their research practice. As will be discussed below, many different barriers existed that curtailed the scientists' ability to convert available online resources into desired research outputs.

To conceptualise the role and reach of data engagement among African scientists, we adapted Amartya Sen's Capabilities Approach (CA) for human development. In contrast to conventional understandings of inequality that stress the provision and possession of resources, this theoretical framework focuses attention on how an individual transforms those resources into assets and the contexts that constrain that capacity (Sen 1999: 109). Goods and services, in short, are not valuable in and of themselves—they must be 'converted' into utilities that a person can use to advance their goals and from which they can ultimately derive some form of value.

In the context of OS, the CA challenges the presumed link between the provision of online data resources and the productive use of data. Exploring, as Sen puts it, "the different types of contingencies [that] lead to systematic variations in the 'conversion' of incomes into the distinct 'functionings' we can achieve"—brings into focus the profound impact that research settings can have on the intellectual projects and partnerships to which scientific activity can give rise" (Sen 1999: 109). Achieving greater utility from data requires, first and foremost, addressing the specific material and social arrangements that need to be in place to enable scientists to effectively engage with data on an everyday basis. In the course of the fieldwork it became apparent that chief among these necessary conditions is basic financing. Issues of funding were discussed by every single interview participant and, as in other parts of the world, determined the scope and scale of research activities, which scientific questions were pursued,

and how. Rather than simply acknowledging that "money is tight", however, a number of interviewees made a noteworthy distinction between the research activities supported by grant money, and the shortfall not covered by the grants. As one participant in SA2 mentioned:

> you know they call us to meetings and they say we have funding for this and that. And I think "great stuff", but I wish they would ask me what the real issues are. I'll probably tell you 100 other things outside of the money [permitted to be spent on the grant] (SA2/1).

Indeed, a range of issues other than project-specific funds, such as facility repairs, equipment maintenance and calibration, off-campus Internet access and personal memberships, also influence data engagement activities. These issues characteristically involve smaller sums of money than those normally covered by research grant funding and were not considered "deal breakers" in the ability to conduct research. In what follows, we examine three types of these "micro-economic conversion factors" and show that they nevertheless play an important role in facilitating or hampering researchers' engagement with Open Data.

Personal Conversion Factors: Membership Fees for Data Sharing

Professional membership organizations, networking initiatives, data sharing sites, and Web 2.0 tools offer scientists important means of communicating with peers, gaining access to data resources, and disseminating their own data outside of traditional publication routes.[2] Increasingly, these sites are becoming relevant to the "altmetric" assessment of research performance and Internet profiling (van Schalkwyk 2014), but also as a means of gaining access to authors' work, sharing data and accessing information.[3] Nonetheless, the membership

of many professional organizations, networking initiatives, data sharing sites, and Web 2.0 tools often involves a small fee. A brief survey of membership costs to these organizations revealed that membership fees of many of them were well above $100 per year.[4]

The presence of these financial requirements has serious implications for many LMIC scientists. Current exchange rates and costs of living in LMICs make $100 a significant financial outlay. At the same time, the ability to claim such membership fees from university budgets or grants is rare, as many facilities do not regard these as "essential research tools". Personally paying these membership fees become even more problematic when there is the need to join more than one organization. As one participant said: "you know, these fees for joining, they add up quickly and you must choose [what to join]" (KY1/9). These costs, however small in comparison to research budgets, inhibited many of the research participants from engaging with these different platforms—thus missing many opportunities to profile and connect their research to that of others'.

The low penetrance of almetrics as a way to document usage of research produced by LMICs scientists further undercut the perceived value of membership-dependent organizations. These tools can capture the ways in which research outputs are disseminated, read and re-used across research contexts, thus documenting the impact of research and potentially augmenting it by multiplying the pathways through which researchers can engage with their audience. However, the efficacy of these tools hinges upon belonging to a broader network of social media sites, some of which are free for use (such as Twitter) and some of which are offered on Freemium models where only basic usage is free (such as citation management systems like Zotero or Mendelay, or networking tools like LinkedIn). This creates a negative feedback loop: their lack of demonstrated utility—no doubt complicated by the issue that many subscribers will only

obtain an entry-level membership—make the investment appear impractical to potential users. One participant, when discussing his membership to a number of professional networking sites made the comment:

> I can't see what it has contributed to me. I don't know why … I don't see any good news coming out of it – someone saying we want you here to do this or that, or give a talk. I've never seen anything (KY1/8).

These issues clearly demonstrate a differing level of access to resources that cannot be framed in terms of access/no access. While all the scientists interviewed had some access to some of the data sharing modalities, very few of them were able to benefit from all the different functions, which curtailed their engagement. The relatively minor financial burden of membership fees influences the manner in which the scientists engage with online data, profile their work and circulate their work, significantly delimiting its impact and reach.

Environmental Conversion Factors: Pay-As-You-Go Internet and Proxy Servers

Considered through the lens of the "digital divide", all the universities visited were firmly "online": staff had access to computers and Internet connection. Nonetheless, the interviews revealed that their ability to make use of their "online" status was more nuanced that it would initially appear. Participants, particularly in Kenya, reported that high teaching burdens, considerable supervision commitments and additional administrative duties occupied a considerable amount of their working time. Many of the participants agreed that much of their working day was spent away from the computer (or engaged in administrative task when at the

computer), and that they had little time to conduct online literature searches or to browse the Internet.

With severe pressures on their time during the working day, it seemed likely that a lot of data engagement activities should occur off-campus, making personal Internet access an issue of considerable importance. Nonetheless, despite the increasing provision of cable-based Internet, roll-out in many LMICs remains limited and costs are high. "Not everybody can access this wireless at home in Kenya", one academic explained

> because also we have a number of companies that have now come up but the payment is high. You pay for what you access - the TV programmes and also the wireless connection. And then every month you are paying an extra bill (KY1/2).

Such situations were even more complicated for those living in informal/less-formal settlements where landline provision is scare (if not absent). A Kenyan staff member highlighted this issue, saying:

> In Kenya people say that we have Internet everywhere, but really how much can you download? And you have to have the equipment to be able to… Some areas in Kenya we know that people can't even access. Although we know the networking has been done but there is an assumption that everyone can access. (KY1/2).

Another participant further clarified the geographic constraints of "being-on line":

> Here I'm using wifi, so the moment you step out of the college you're shut off and again in the estates [less-formal residential areas] where we stay as of now the Internet is a bit expensive. It's not affordable. So I do as much as I can here so that when I go back home I'm going to rest (KY1/3).

Thus, while some academics may have Internet at home, a large number of students and researchers continue to struggle with personal Internet provision off campus.

Moreover, in comparison to many high-income countries, buying data in African countries (particularly through pay-as-you-go bundles) is expensive—a situation that is exacerbated by low salaries and student bursaries. In both South Africa and Kenya this was a common concern, with participants frequently making statements such as:

> You bought the data bundle, but what you have is not enough for you to download any publication or anything like that (KY1/2).

The financial limitations on data usage were a central concern for postgraduate students. "Most of our students," a Kenyan supervisor commented:

> [W]ould be able only to support 10 MB data bundles which are cheap. But this one they just use for communication, for play around, but they are not looking at the scientific information (KY1/2). [5]

These costs are likely to limit the amount of browsing, uploading and downloading that occurs, with significant implications for the use of Web2.0 modalities, Twitter, professional

networking and so forth. In this way, data engagement channels and access to information are severely curtailed due to micro-economic concerns. Thus, despite being "online" and having access to computers, engagement in data sharing continues to be shaped by financial concerns.

A related issue concerns accessing university resources when off campus. Only one of the four universities visited had a proxy server set up to assist off-campus access to library resources, however, in general, remote access to the library collections was the exception to the rule.[6] If researchers wanted to access papers from home, they would have to pay a reader fee for many of them (exacerbated by the lack of time for online activity during the teaching day), something that was consistently agreed to be prohibitively expensive. As one postgraduate student said:

> We're told to buy. But you can't buy because it's expensive. They talk of, like $80. That is times 80, like KSh 6400. That's a lot of money (KY1/3: postgraduate student).

The issue of paying for papers was much discussed also because of limited library access to desired journals. Participants based in Kenya claimed that they often had to purchase articles they needed using their own money, as the universities had no resources to pay access fees:

> There are some articles that you can find online, and then when you try to get it then you have to buy. In that case we cannot access them. Because our financial situation is not good. But there are some which we are able to access and they are free (KY1/6).

This issue, together with the lack of support from institutional libraries, is evident in the short exchange below:

> KY1/5: what stops me from getting data is that some journals you're supposed to buy.
>
> LB: so it is the pay-to-view thing that is the problem? And the library doesn't help you?
>
> KY1/5: you see, anything in the library, they hold books. So I don't think there is anything in those books.
>
> LB: so you can't write to them and ask them to get an article for you?
>
> KY1/5: no.

While many Open Access journals make special provision for LMIC *authors* (such as waiving author fees), fee waivers to assist LMIC scientists in accessing articles from non-OA journals is less common, and access fees can be in excess of $50. These costs shape the manner in which they conduct their online research and engage with data. As one postgraduate student put it: for me, when I find that I'm required to pay I just leave that paper (KY1/6).

A number of different initiatives have addressed some of these access restrictions by providing OA portals, providing cheap or free access to databases and e-journals, creating repositories of e-books and addressing infrastructural issues.[7] Interestingly, however, none of the study participants mentioned these initiatives explicitly: even those who were asked to fill in a data journal of their daily online activities, OA portals were not featured.[8] It is likely that lack of exposure to these initiatives, together with the issues of Internet provision discussed above, limited the awareness of these initiatives at the fieldsites. The lack of ability to mobilise funds

to buy the necessary publications thus greatly shapes what articles and data are available to scientists.

Material Conversion Factors: Buying Software and Hardware

Although all the staff and students who participated in the study had access to a computer and an Internet connection, when questioned about the provision of this equipment it became evident that purchasing software and hardware was usually the responsibility of the individual instead of the institution. This raises an important concern: the inability to regularly update research hardware and software places researchers in a position in which they are unable to effectively make use of online resources—particularly the newer Web 2.0 modalities that require up-to-date software.

Getting up-to-date software—and access to all the software that was desired—appeared to be a challenge experienced by all the participants at all the fieldsites (to some degree or another). Common to all the sites was that the universities were often unable to provide institute-wide access to software programmes, and thus the responsibility for purchasing fell to the individual researcher. This is evident in the exchange below:

> KY1/1: Oh dear, supported [by the university], I don't think so. Software-wise we just get software through your own means. Like now, even for example the operating system is supposed to be given. Like now with moving from Windows XP to Windows 7 the university is supposed to have the license otherwise you have to purchase.
>
> LB: You don't get it automatically?

KY1/1: No, you don't get it automatically.

LB: And other chemistry software – you'd have to buy it yourself?

KY1/1: Unless it it's free for download. Otherwise you just have to purchase that. And the department cannot purchase software for the staff. They do not have… perhaps they would have wanted but they do not have the capability.

Again, such situations were exacerbated for postgraduate students. While supervisors attempted to purchase software out of their research budgets when possible, it often fell on the students to purchase their own software out of their limited student stipends. The response from a postgraduate student below underscores the issue:

LB: So you have to buy software yourself or does your supervisor buy it for you?

KY1/4: We buy it ourselves.

With regards to hardware, on the South African sites the majority of staff interviewed confirmed that the university had provided their computers, and that they were often able to provide their postgraduate students with computers from their research budgets. Additional concerns were raised about computing and storage power, however. As one staff member put it: extra storage and computing aren't covered by my grant, but I may be able to shift things around (SA1/11). Moreover, there was considerable heterogeneity across sites regarding hardware provision:

We had a problem—I don't know if it's in other countries – but in South Africa we had a problem that most donor agencies – now it seems that they are discussing to change it—but the funding companies including the NRF [National Research

> Foundation] when you ask for computers – you can ask for anything else but not computers […] My masters students made a proposal for their masters project and they had R50000 per master, but they could not ask for a single computer on their budget. So they ended up not being able to spend the budget because they … don't allow conferences and computers on that budget and we don't need anything else. It's so silly! (SA2/12).

Similarly, in Kenya neither staff not students were provided with hardware from the research institutions. "We have laptops, but they are not provided by the university" (KY1/3: postgraduate student) was a common theme running throughout the interviews. When questioned further about the provision of ICT equipment, it became apparent that everything was the responsibility of the individual researcher. As one staff member complained: we must even pay for our own paper for printing! (KY1/9).

The policies governing research grants and institutional processes thus impact data engagement activities by dictating the *manner* in which research funds could be spent. The problem is often not the absence of money for research, but rather the freedom to redirect funds (often negligible amounts) to improve the research environment—a constraint that curtailed what activities were possible within a specific laboratory context and what kinds of projects and partnerships a scientist could pursue.

Beyond Access: Realizing a Minimum Level of Engagement

Our fieldwork suggests that policy initiatives that seek to close the 'digital divide' by *extending* online access fail to grasp the dense regulatory, personal and physical processes through which scientists engage with data online. More to the point: the dichotomies that underpin the very notion of the "divide: - e.g. online/offline and access/no access—do not tally with the partial and uneven ways in which Internet resources circulate. Thus while large-scale infrastructural investments (such as electricity and Internet provision) would undoubtedly improve the working conditions of scientists, it is clear that even modest changes to Internet provision could have a dramatic impact on the value of online access—both for individual researchers and for the broader international scientific community.

These micro-economic factors, we believe, must not simply be viewed as general problems that "poorly resourced" laboratories confront, but rather conceptualised as the platform from which to foster the egalitarian aspirations of the OS movement. Current OS discussions push towards more data accumulation, more openness and more internationalization, without however considering the local conditions under which such openness can help researchers. Put simply: OS understands democratizing science *as increasing the amount of data available.* Rather, our analysis of the micro-economic factors that impact research suggests that to realise that egalitarian vision first requires ensuring that *all individuals have a certain level of ability to engage with data*—or what we might term a "minimum level of engagement" with online resources.

Along these lines, we can ask whether current levels of access experienced by many scientists working in sub-Saharan Africa—in terms of their ability to access Web2.0 tools, online data sets, chat sites and so forth—are acceptable in light of the commitment to egalitarianism, or whether more needs to be done. Unpacking this question involves a critical evaluation of how

a diverse data engagement modalities work in practice and how they might be altered so that scientists might benefit from them. Membership fees, for instance, could be removed for certain key sites. To facilitate downloading in low bandwidth areas, the format of files in some databases could be changed. Providing viable open software alternatives to key programmes—ones possibly designed in-country—could enhance the capacities of local researchers and reduce dependency on partners in the north. Some initiatives, it must be noted, are already trying to achieve these changes with responsive design. However, clearly what is necessary is a *global, coordinated, inter-disciplinary and multi-focused discussion* on how to pull these diverse aspects together into a coherent approach.

The scrutiny of existing data sharing modalities in terms of a minimum level of engagement might encourage discussions on how future data sharing initiatives should be structured. Such discussions need to recognise that treating ICT as a homogenous category may lead to overlook the nuances of a minimum level of engagement. If "ICTs" are instead treated as an umbrella term for a "range of technological applications such as computer hardware and software, digital broadcast technologies, telecommunication technologies such as mobile phones, as well as electronic information resources such as the World Wide Web" (Selwyn 2004, p.346), the potential subtleties of inequalities will become visible, within and between these different technologies.[9] The dominance of cellular phones on the African continent—in comparison to other ICTs—and their increasingly effective use in a wide range of financial and health related applications should provide a focal point for OS initiatives on the continent—too many websites critical for data engagement are highly cumbersome for use on mobile devices (Kumar 2013; Tomlinson et 2009). Even more pointedly, the rapid proliferation of mHealth technologies, particularly in the field of diagnostics—raise a number of questions as to how clinical data will be regulated—whom will be granted access and for what purposes (Kaye et

al 2011). The context-specific opportunities of data re-use, in addition, to constraints are discussions on a minimum level of engagement should take into account (Selwyn 2004, p.348).

Needless to say, determining what might constitute a minimum level of engagement is complicated by the diversity of research cultures around the world. According to the Global Research Council Report,

> "[t]he structure of academia and the research communities, the landscape of publishers, and the funding of research and publications vary from country to country just as the interaction between the stakeholder groups also varies. Taking into account these differences, specific approaches towards implementing open access that are well suited for country A might not be feasible in country B. [Furthermore], in implementing open access, issues of language and standardisation need to be taken into account as well as differences which might arise from differences between scientific disciplines" (Global Research Council 2013, p.2).

It follows that a key aspect of a 'minimum level of engagement' would also include the ability of scientists to address aspects of their research environments that act as negative conversion factors for data engagement within their specific research context.

Many of the micro-economic concerns discussed above fall outside current funding and regulatory structures. Faculty are thus unable to use the money available for research to buy membership to networking sites, purchase mobile data, hire teaching assistants, get access to key journals and a wide range of other activities that would streamline their research and

facilitate their data engagement activities. The situation for Masters and PhD students—those who were carrying out the bulk of research in the laboratories visited—is even more acute.

Elsewhere, drawing on experience in development studies with micro-funding as well as cash transfers, we have offered the notion of 'micro-funding' as a means of addressing what falls outside of current funding structures. The basic rationale underlying this proposal is that many scientists in low-resourced environments would benefit considerably from the ability to access modest flexible funds, made available to individuals or through intermediary organisations, such as national academies, professional associations or licensing bodies, to alter aspects of their research environment that *they* identify as problematic. Instead of assessing such support on the basis of its rate of 'profitability' or 'repayment rates' (as is common in the case of micro-credit finance schemes), the 'return' from such small level funding could be judged either through standard measures of research outputs and productivity or through criteria proposed by researchers themselves.

The idea of a micro-funding scheme resonates with the first quote of this paper, where a researcher in South Africa expressed his wish that funders would ask him "*what the real issues are."* Our hope is that such systems would generate new sites of agency and capacity by allowing scientists to tailor their research environments according to their in-depth understanding of the frustrations of daily research. More than this though, if calls for researchers in resource challenged environments to engage in OS where linked to the redressing of their frustrations, such an enabling approach could offer an alternative to imploring or demanding researchers make their data available to others. Giving scientists working in Africa the power to alter their research environments in ways they felt would best support the work they felt was most significant to pursue.

Concluding Comments

This paper demonstrates that effective engagement with online resources is not simply a matter of access to ICT infrastructure and resources—a concern which, up to this point, has dominated OS discussions. The accessibility of services can neither be equated with resource allocation or the adequacy of supply; rather the degree to which individuals utilize a resource depends upon the specific conversion factors that inhibit or facilitate engagement. Empirical fieldwork on the routine practices of scientists allows us to critically unpack current framings of openness in scientific research and to reframe them using the CA—an economic theory of poverty and development that we feel works well also in the scientific context. We point to the key issues of "lowered engagement" and inefficient resource conversion that fundamentally influence data engagement activities. In this way, we offer an alternative framing of research and development in Africa—and introduce a contrasting understanding of the perpetuation of "data poverty" and activities to redress these inequalities.

In keeping with the CA, the notion of a minimum level of engagement forces us to question what exactly is necessary for effective data handling and how we can safeguard that all scientists around the world are able to access and enact at least a core set of capabilities. In effect, this challenges funders, learned societies and public bodies to refrain from focusing on how much data are "out there" or making assumptions about the publics that will be served by it, but instead to ask how best they can ensure that researchers and others can make some use of data in order to address social needs. The point will resonate with anyone who has worked in health communication: the *reach* of health messaging does in no way guarantee its *uptake*; how biomedical information is interpreted and acted upon is circumscribed by local contexts

of care (e.g. Chandler et al 2008). Public engagement—whether those publics are composed of patients, scientists, community members—does not occur in a deliberative vacuum, but is intimately shaped by the social, political and material settings in which those engagements take place (Leach, Scoones and Wynne 2005; Burton 2008).

The idea of a system of micro-funding forms a logical starting point for foregrounding these dimensions of engagement. A micro-funding system would not only recognize that scientists are intimately interconnected to their research environments, but also that they need agency to alter these sites, and that such agency is often mediated by financial factors. Enabling researchers to directly address these issues, rather than relying on grants from global funders or core-funding from institutions, might also enhance their capacities to engage with data and quite possibly alter the landscape of science and further, global health—the questions it can address, the specific publics to which it relates, and how that relationship is carried out.

Indeed, what kinds of scientific publics might arise from these new capacities? First, it must be noted that LMICs already struggle in this area due to relatively low levels of science literacy within the general public. Continuing to have barriers to online information may thus be critical in undermining efforts to foster "public trust in science as a source of reliable knowledge and thus as a legitimate source of information" (Leonelli 2013: 8), and even more significantly, in considering who is involved in scientific research, to whom are the outputs of such efforts directed and to what end. Is OS to benefit and involve the whole population, or does it concern specific communities, such as literate individuals or patient groups? Do all citizens hold an equal interest in all aspects of science at all times, and if not, how do we conceptualise the relation between producers and users of knowledge? How might attention to that relationship impact the applications of science to public health? And what can the barriers

to accessing online experienced by scientists—arguably the best placed to take advantage of these open accesses initiatives—teach us about deepening engagement across African publics more broadly?

These questions need to be addressed when discussing OS, and the role of mediators and lobby groups explicitly recognised—for instance, citizen advocacy groups have become increasingly important players in orienting biomedical research agendas and setting public health priorities in high-income countries. Unnecessary financial costs of online data represent considerable barriers to the public engaging with research, per se, but from benefiting more directly from its potential applications to healthcare. In involving more publics in evaluating the impact of research and its relevance, a genuinely more global open science could ultimately help foster more equitable approaches to global health.

It is clear that data sharing approaches need to be modified so as to be internationally meaningful while retaining practical utility in differently resourced research environments. In particular, we need to shift debate to reflect the *capabilities* necessary to exploit the data that are increasingly being made available online, as well as those necessary to share the data generated. How, for instance, can diverse issues such as the structure of websites, the availability of personal computers and the speed of the Internet connection, preferences in data selection and manners of sharing all be meaningfully framed in data sharing discussions? Stretching the conditions for research engagement beyond issues of inclusion and exclusion banishes the notion that capacity building is simply a matter of making more data available. A minimum threshold for engagement might ultimately help open new avenues for science to advance outside the dominant, high-tech laboratories that characterize the "North"—a more "frugal" science, perhaps, but one that could ultimately generate more innovative and productive solutions for the publics and public health settings within its reach.

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Notes

[1] The average length of the site visits was 3 weeks, during which time the researcher (LB) observed laboratory practices, engaged with institutional activities and conducted semi-structured interviews. A total of 56 interviews (23 at two South African sites and 33 at two Kenyan sites) were conducted amongst postgraduate students and staff members. The issues raised in these interviews - particularly the perceived barriers to data usage and contribution - were further informed by observations of the laboratories and the working practices of staff within these facilities.

[2] Web2.0 tools include social networking sites, blogs, wikis, folksonomies, video sharing sites, hosted services, Web applications etc.

[3] By altmetric tools we refer to non-traditional metrics to track academic contribution (as compared to traditional citation impact metrics, such as impact factor and *h*-index). The term altmetrics can be applied to articles, as well as to people, journals, books, data sets, presentations, videos, source code repositories, web pages, etc.

[4] Regular membership to the American Chemical Association currently costs $162 per year, for example.

[5] To further complicate matters, many students are unable to take advantages of the deals and bundles offered to contracted clients, and have to rely on rechargeable credit ("pay as you go").

[6] At two of the sites a small number of participants mentioned the existence of a proxy server, however they were often unable to give details of off-campus access, and their statements contrasted strongly with the majority.

[7] Summarised at http://www.ilissafrica.de/en/howto/OpenAccessGuide.html (Accessed 03/03/2015).

[8] See (Research Information Network et al. 2009)

[9] Furthermore, it is vital to recognize that the Internet itself is not a "fixed object, but rather a protean family of technologies and services that is being rapidly reshaped through the interacting efforts of profit-seeking corporations, government agencies and nongovernmental organizations" (DiMaggio & Hargittai 2001, p.3). Thus, they suggest that the inequalities evident in ICT utilization are not simply through the differences in individual resources, but may also be through the way in which "economic and political factors make such differences matter" (DiMaggio & Hargittai 2001, p.3). And it is, of course, important to reiterate that the inequalities between these technologies may vary considerably.